

# The invaluable Contributions of Dry Rubber Content (DRC), Total Solids Content (TSC) and Mechanical Stability Time (MST) to Rubber Quality and Overall Quality of the Dipped Goods Manufacture.

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*Abstract - DRC, TSC and MST are very important and indispensable parameters in the production and processing of dipped goods and the dry rubber. These parameters are suitable for the ensuring of high quality items such as hand gloves, condoms, balloons, catheters, tyres, balls, tubes, footballs, volleyballs, basketballs, handballs, goofballs, tennis balls amongst others. Due to the low DRC of freshly tapped NRL, a method has to be used in increasing the DRC, from about 30% to about 60%, before it can be used to make dipped goods. Various methods of concentrating NRL, exist. However, creaming with chemicals is simpler and easier. Three chemicals were used to cream the latex. The conventional material sodium alginate, Tamarind Seed Powder, Cassava Processed Effluent and an equal portions of Cassava and Tamarind. The fourth, equal portions of cassava and Tamarind, showed the best results followed by cassava and sodium alginate and Tamarind.*

## I. INTRODUCTION

The industrial growth of any nation starts from the utilisation of the available and abundant raw materials. The export of these abundant raw materials, without adding value, can't continue, albeit the low prices, being paid for them, due to their unfinished nature and low value. In fact, all over Africa and most third world countries, that is the norm. This system impoverishes Africa as the low prices can not sustain

any economic growth and development. This paper aims at encouraging local and indigenous production and technology, through the establishment of small and medium scale industries and mass employment too. As a follow up, we are trying to explore and exploit our abundant agricultural resources, that are wasting. Cassava Processed Effluent and Tamarind Seeds Powder are two abundant natural resources, that can be used in the rubber industry and food industry too. Cassava starch is a delicacy, but in the process of producing it, the effluent can be put to suitable use as a creaming agent in NRL compounding and formulation. Cassava performed very excellently as a creaming agent and is recommended for mass exploitation.

## II. EXPERIMENT AND CHARACTERISATION OF THE CREAMING AGENTS

After the experimental work involving raw materials procurement, samples formulation and preparation, characterization of the raw materials and samples, the results obtained are discussed as follows:

The creaming agents, sodium alginate (SA), TSP, CPE and CPE + TSP, suitability were determined by measuring their pH, gel time and density and the results obtained are as follows shown in table 4.1.

Table 2.1 pH, gel time and density values for SA, TSP, CPE and CPE + TSP

Creaming Agent	pH	gel time minutes	density \$g/cm^3\$	Bulk density \$kg/m^3\$
SA	8.00 - 10.00	12 – 22	1.00 - 1.61	900
TSP	5.00 - 5.38	1.35 - 1.42	0.46 - 0.65	650
CPE	5.44 - 6.43	18 – 21	0.42 - 0.81	810
CPE + TSP	6.00 - 7.00	0.9 - 1.0	0.75 - 0.85	950

The pH values found for the creaming agents agree with the values arrived at by Harini, Salsabillah & Gusmaline in 2015. These pH values also agree with

Yong-Huang, Gong, Xiao & Yao in 2024. Okoronkwo, Mbaeyi-Nwaoha & Okoyenzu also in 2020 and Solarvanel, Amin & Soefrani in 2025 and Nagar, Dash & Rayguru in 2022 all agreed and found out similar values for the pH of SA, TSP and CPE.

The gel times (setting times) of sodium alginate (SA), Cassava Processed Effluent (CPE) and Tamarind Seed Powder (TSP) perfectly agree with the studies carried out by Ingo & Adetunji in 2024 and with those of Wang, Sun & Mu in 2024. Also, these values of setting times reasonably agree with the findings of Geethalaxmi, Sunil & Venkatachalapatty in 2024. Similar values were also obtained by Kaffo Brou & Komenan et al, 2024.

Density values also closely agree with the same ones obtained by Nasir, Javaid & Hanif in 2026 and Akinola, Sunmonu & Adeyanju, 2025.

The pH, gel time and density values of Cassava Processed Effluent (CPE) and Tamarind Seed Powder (TSP) are close to the values of sodium alginate (SA), which is the reference material. Also, a mixture of CPE and TSP at 1.5g each gave very good values of pH, gel time and density.

From these studies, CPE and TSP could serve as good creaming agents for Natural Rubber Latex, because of the closeness of CPE and TSP values of pH, gel time and density to the reference material, SA.

### III. DETERMINATION DRC, TSC AND MST OF THE CREAM CONCENTRATED NATURAL RUBBER LATEX (NRL)

#### 3.1 Dry Rubber Content (DRC)

Table 3.1 DRC of samples of latex creamed with SAL, CPE, TSP and CPE + TSP.

Creaming agent	DRC %
SAL	62.50%
CPE	64.50%
TSP	63.32%
CPE + TSP	65.00%

The values of DRC above, agree with those of Suksup, Imkaew & Amithpong (2025). Ilele, Nie & Okayange (2024), Kaesaman, Chuaysakul & Nackson (2025) also found out similar values of DRC for SAL, TSP, CPE and CPET TSP creamed NRL. From these values, NRL can be creamed with either Cassava processed effluent or Tamarind Seed powder or a combination of cassava processed effluent and Tamarind Seed powder, since the values of DRC obtained for them compare favourably with those of sodium alginate creamed NRL and in some cases seems to fare even better.

The DRC of Natural Rubber latex (NRL) or coagulum is the weight percentage of solid pure rubber (polyisoprene) in the latex. It determines the market value of the raw NRL. A higher DRC indicates a stronger, more stable and expensive industrial material. Typically, DRC for fresh field NRL ranges from 25% to 35%.

Methods of measuring DRC (based on ISO 126-2005) entails the following: Coagulate a known quantity of NRL with 2% acetic or formic acid, washing, drying the coagulum for about 6 hours to 12 hours at 100\* L to about 105\* L. Drying is stopped when a constant weight is achieved. The ratio of dry rubber to the total sample weight is used to calculate the DRC of the latex.

A hydrometer called a "Metrolac" is used to quickly determine the DRC of NRL. The Metrolac is placed into a diluted NRL to provide immediate value. A Microwave Technique can also be used to determine the DRC of latex. A very advanced system uses an Optical Sensor Method.

The formula for calculating the DRC of latex is shown in equation 4.1.

### IV. RESULTS AND DISCUSSIONS

$$\text{DRC\%} = \frac{\text{Mass of dry rubber (g)}}{\text{Mass of latex sample (g)}} \times 100$$

#### 3.2 Total Solids Content (TSC)

The TSC of Natural Rubber Latex (NRL) is the percentage by mass of non-volatile materials (rubber, proteins, resins, minerals etc) remaining after drying, usually 50–65%, 30–35% for freshly tapped latex and about 50–65% for concentrated NRL. It indicates quality, thickness and film strength. It's measured by heating a weighed latex sample, typically at 100\*C 120\*C for 2 hours, until no further loss in weight occurs.

Methods of measuring TSC (ISO 124 BS Method) Weigh a clean dry and cool container to the nearest 0.1mg. Add \$2.0 \text{ } \backslash \text{pm } 0.5\text{g}\$ of NRL sample to the

dish and weigh again immediately. Place the dish in a hot air oven for 2 hours, till weight is constant.

For TSC% =  $A - B \times 1000 / V \text{ sample (ml)} \times 100$   
 where A = weight of dried residue + dish (g)/final weight

B.= weight of the dish (g)/initial weight  
 and V = sample volume.

Or percentage (%) solids = Dry weight of sample (g) / wet weight of sample (g) x100

The values gotten from the experimental determination of TSC values of SAE, CPE, TSP and TSP + CPE creamed NRL, agree with the ones also arrived at by Maraphum, Wanijantuk & Hanpinitasak (2022); Wijaiyo, Rachmawan & Andriyanto et. al; (2019) and Sirisomboon and Lim, (2010) also found out similar values in agreement with the values of TSC obtained.

### 3.3 Mechanical Stability Time (MST) (ISO 35 ASTM D 1076)

Table 3.2 MST values for different creaming agents

Creaming Agent	MST	Units	Time achieved
SAE	650 – 1000	seconds	3 days
CPE	660	seconds	5 days
TSP	650	seconds	17 days
CPE + TSP	800	seconds	2½ days

MST values increases with longer incubation times during the creaming process. The process improves the overall quality of the latex with high TSC and DRC suitable for manufacturing foam rubber and dipped goods like medical hand gloves.

The MST values for the various creaming agents used show striking similarities. SAE which is our reference material showed the highest value, at 650–1000 seconds, followed by the combination of CPE + TSP at 800 seconds, and CPE at 660 seconds and finally TSP at 650 seconds. These values quite agree with the standard 650 seconds and above required for NRL. Hence, CPE and TSP are good candidates to replace SAE, and a combination of both being excellent and ideal for creaming latex.

Those findings also agree with the results of the studies carried out by Kalsaman, ChuaySakul &

The MST of NRL is measured by agitation at 14,000 rpm. MST is defined as the time in seconds required to produce initial signs of clotting (coagulation) and/or coagulum, when latex is stirred at high speeds, representing its resistance to mechanical agitation. It's generally required for MST of latex to be between 450 to 800 seconds (7.5 minutes to 13.3 minutes) for good quality latex.

Higher MST values signify better resistance to shearing and coagulation during processing and values above 600 to 650 seconds are often preferred for industrial manufacturing applications.

Standard method of testing MST is (ISO 35), some usually by stirring a standardized latex sample at 14,000 + 200 rpm until coagulation occurs. The importance is that MST is critical for manufacturing process to ensure the latex withstand pumping and transportation without coagulating.

Nakason (2025), Suksup, Imkaew, & Smithipong (2025). In their research, they found out similar values for SAE, CPE and TSP creamed NRL.

4.2 The Quantity of Creaming Agent Required for the preparation of creamed concentrated NR Latex. Figure4.1, shows the quantity of creaming agent at 1,2,3, 4, 5, 6, 7, 8, 9 and 10ml in the fresh NR Latex at 25ml. the process of creaming was observed at different incubation times. This figure shows a relationship between the incubation time and the quantity of the creaming agent. It was noticed that the incubation time decreased with increasing amounts or quantity of value at about 5ml of the creaming agent. So the optimum quantity of creaming agent is 5ml for fresh NR Latex at 25ml. this optimal ratio will be used as a standard.

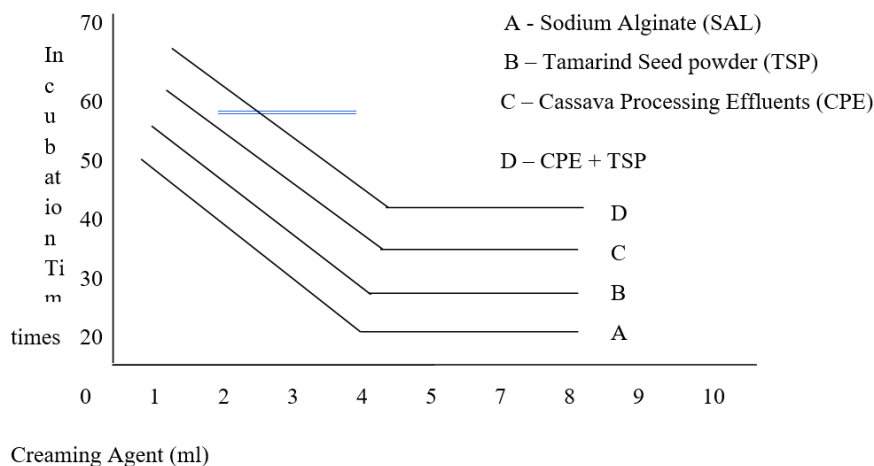


Figure 4.1 The Relationship between the quantity of creaming agent and incubation time.

#### 4.30 Properties of Cream Concentrated NR Latex

These properties are highlighted as follows: The characterization of fresh NR Latex and cream concentrated NR Latex were compared in table 4.3, when fresh NR Latex was transformed to cream concentrated NR Latex by creaming using Sodium Alginate, (SA) tamarind seed powder (TSP), Cassava Processing Effluents (CPE) and a mixture of TSP and CPE, it was observed that the TSC and the DRC values of the cream concentrated NR Latex were much higher than those of the fresh NR Latex.

The creaming agents do assist in efficiently separating and packing the rubber particles from the serum solution. A proof borne out of the higher TSC and DRC. No much change was observed in differences in the alkalinity and VFA of fresh NR Latex and cream concentrated NR Latex. The cream concentrated NR was also incubated for 1, 3 and 7 days at ammonia in NR Latex and VFA indicated the extent of degradation of the latex by micro-organism.

Table 4.2 shows the parameters of fresh NR Latex and cream concentrate NR Latex.

Parameter	Fresh NR Latex	Cream Concentrated NR Latex
Total Solid Content (TSC) (%)	38.00	46.32 – 47.00
Dry Rubber Content (DRC) (%)	27.88	45.00 – 45.50
Alkalinity (%)	0.677	0.148
Volatile Fatty Acid (VFA)	0.0435	0.033

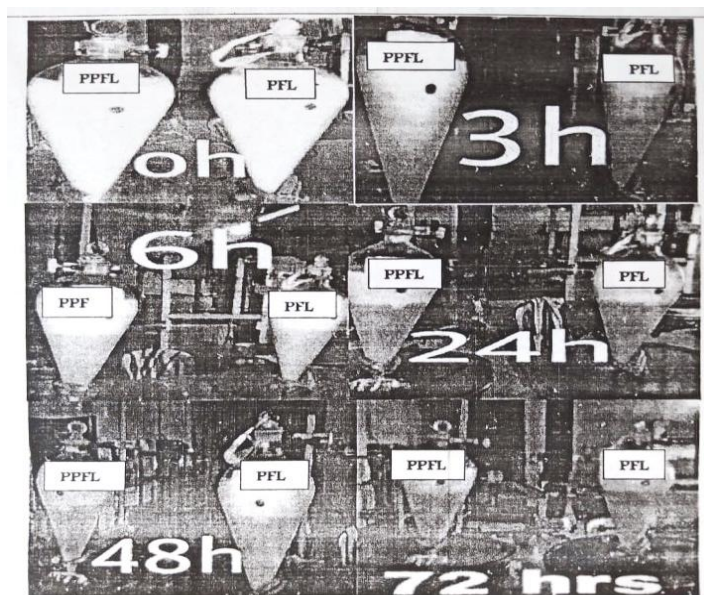


Figure 4.2 Plate showing creaming times

From the results obtained, Cassava effluent and Tamarind seed, can very function as creaming agents for rubber production and a combination of both really shows very excellent results. This can be seen in the results obtained above. If embraced, the country would reduce money spent on exports and reduce the high cost of importing Sodium alginate.

This is due to the fact that all kinds of rubber particles could possible move /diffuse from the continuous /serum phase into the creamed layers during the creaming process. On the other hand, the process of centrifuging results in the separation and removal into the skin latex portion, of smaller rubber molecules and particles; this leaves only bigger particles in the NRL.

Scanning Electron Micrograph (SEM) of the creaming process

Photographs of various types of NRL particles are shown in plates 4.2 to 4.6. It is clearly observable that the CCNRL particles in (a) consisted of both small and large particles, in similarity to the particles of the fresh NRL in (b). The CCNRL showed a far higher larger number of larger rubber particles due to coverage of CPE, TPE and SAL at the surface of the particles. In the centrifuged CCNRL (c), a majority of large and regular particles with a few number of smaller particle sizes were noticed.

4.2 The molecular model of the creaming process utilizing CPE, SAL and TSP

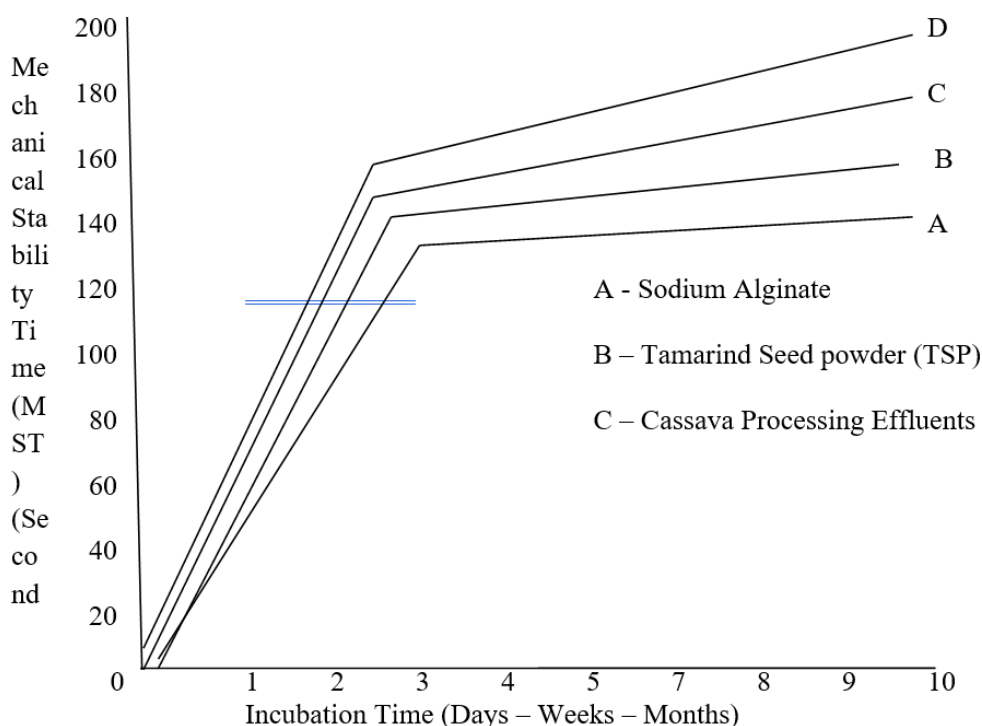


Figure 4.4 Graph of MST Values results incubation time for CPE, TSP and SA represented by C, B and A respectively.

From the figure 4.4, CPE creamed NR latex was the highest MST values, followed by TSP and lastly SAL, which also goes to confirm CPE (starch) as an excellent creaming agent.

4.3 The Molecular Model of the Creaming Process Utilizing CPE, TSP and SAL.

The polymers of polysaccharide origin used as creaming agents usually exhibit a very high degree of polarity (due to the hydroxyl groups, OH) and the sequences of the mannuronic and guluronic residues

from the f - d - mannuronic and (m) and a - l - guluronic acid (G) monomers. While, for the tamarind and cassava starch, the structures are made up of  $\alpha$ -1,4 - glucosidic and  $\alpha$ -1,6 - glucosidic residues and linkages from analse and amylose and amylopectin with many hydroxyl groups, -OH, much like sodium alginate (SAL), tamarind, seed powder, cassava processing effluent and sodium alginate all polysaccharides usually, creaming agents are mostly polysaccharides.

This is due to this property of gelling, swelling chelating and hence making the substable or more viscous for the particular technological application. (Chem book, [www.sciencedirects.com](http://www.sciencedirects.com) and [www.europa.ev.essojournal](http://www.europa.ev.essojournal) )

The creaming agents employed; (a) sodium alginate (SAL). (b) Tamarind seed powder (TSP) and (c) Cassava processing effluent (CPE), molecules covered the surface of the rubber particles as shown in figure above. The absorption of the creaming agent molecules, usually results in elongated incubation periods. The branches and segments of the creaming

agent molecules are usually interwoven, intermingled, entrained and entangled among and with the neighbouring rubber molecules. This extends elongates, expands and thereby increases the size of the rubber molecules. The higher the molecular weight of the creaming polymer, with a lot of negatively charged by hydroxyl groups (or -OH groups), the higher the viscosity of the cream concentrated NR latex and hence the sluggish and slow movement of the rubber molecules. This was among the findings of Singh in 2018 and also agrees with that of Yu et al in 2019.

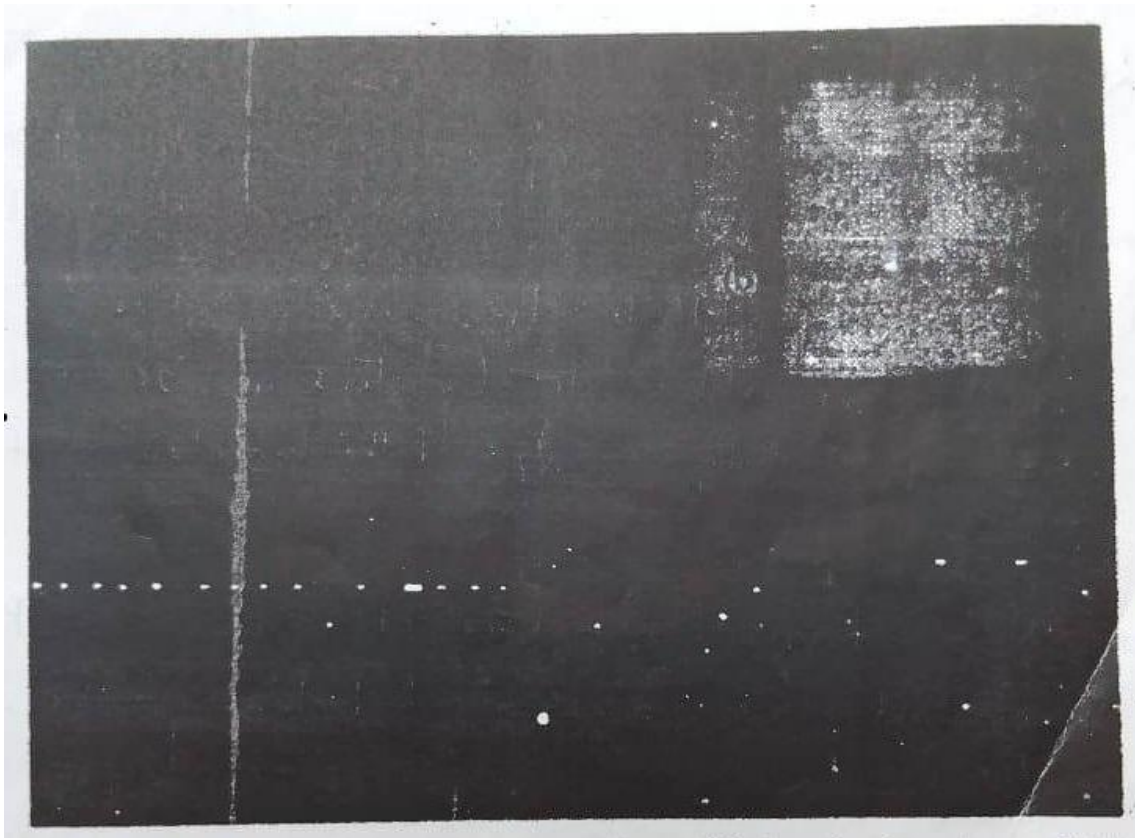


Plate 4.3 Segregation onset

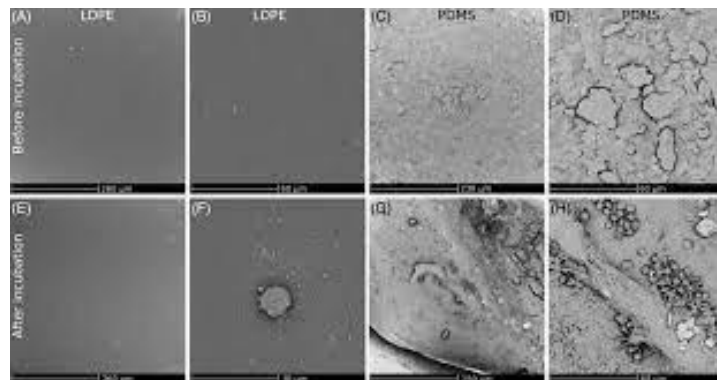


Plate 4.4 Photograph of NRL segregation with incubation times

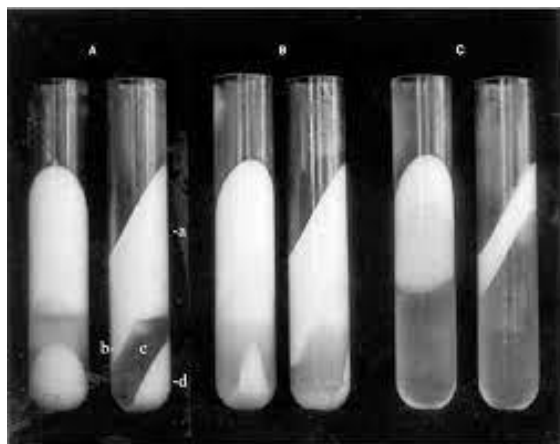


Plate 4.5 Photograph of segregation, in a test tube at onset and finally

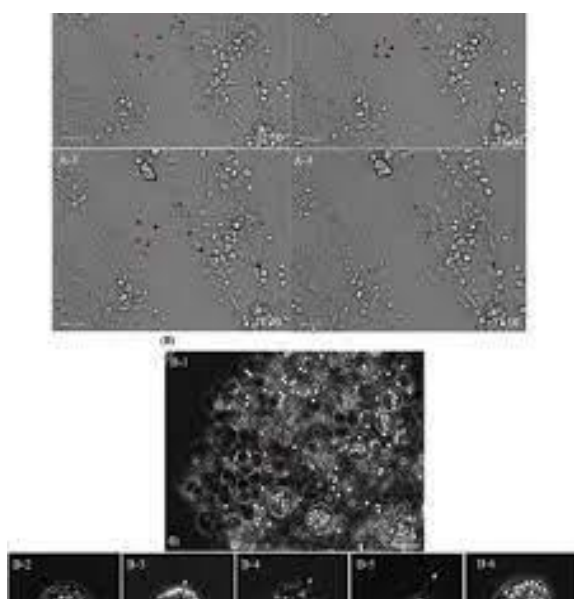


Plate 4.6 Micrographs of segregation

## V. CONCLUSION AND RECOMMENDATIONS

The results arrived at above show that cassava effluent and Tamarind seed, can do better than sodium alginate, which is the existing conventional creaming agent in use. The high cost of sodium alginate necessitates the search for and testing of other cheaper alternatives. Cassava effluent is usually wasted in garri processing and starch too. Effluent is very available and abundant and very very cheap too. Tamarind seed on the other hand too is very common. A combination of the two performed excellently as the results earlier on showed. With a proper utilisation of the nation's abundant natural resources, Nigeria can really industrialize very quickly.

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